Unlocking the Connection:

Understanding Auditory Processing Disorders and their Impacts on Academic Success

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Meet the Audience

- Raise your hand if you are a Speech-Language Pathologist
- Raise your hand if you are an Audiologist
- Raise your hand if you are currently screening or diagnosing APD
- Raise your hand if you have someone on your caseload that you suspect, or know, has APD

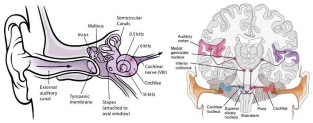
Learning Objectives

This presentation aims to equip school-based speech-language pathologists and audiologists with a deeper understanding of Auditory Processing Disorders (APD) and their impact on academic success.

- Define Auditory Processing and Auditory Processing Disorders (APD)
- Discuss APD subtypes and their presentations within the classroom
- Distinguish APD from other learning and communication disorders
- Understand the impact of APD on academic performance
- Discuss available screening measures for APD
- Identify the role of the Speech Language Pathologists and Audiologist in diagnosis and management of APD
- Discuss how to develop effective intervention strategies for students with APD

Overview of the Auditory System

Key Function of the auditory system is to detect and interpret sound by converting sound waves into neural impulses that the brain can process.



Peripheral Auditory System

Central Auditory System

	Hearing	Auditory Processing
Definition	The physiological process of capturing sound waves through the ear and transmitting them to the brain.	The brain's ability to interpret, organize, and make sense of the sounds that are heard.
Process	Sound waves enter the ear, vibrate the eardrum, travel through the middle ear bones, and reach the cochlea, where hair cells convert vibrations into electrical signals sent to the brain via the auditory nerve.	Upon receiving sound signals via the auditory nerve, information travels through the auditory brainstem to the auditory cortex, where it can then be utilized for higher level language and cognition.
Impairment	Hearing loss occurs when there's a disruption in this process, due to damage in the outer, middle, or inner ear, or along the auditory nerve, leading to reduced volume or clarity of sound.	Auditory Processing Disorder (APD) occurs when the brain has difficulty processing sounds accurately, despite normal hearing. Individuals with APD may hear clearly but struggle to understand and retain spoken language, especially in noisy settings.
Assessment	Determine hearing sensitivity at various frequencies, typically through use of pure-tone audiometry.	Determine brain's ability to process auditory information through a battery of tests that assess a variety of auditory skills, such as speech understanding in noise, speech-sound discrimination, auditory memory, and temporal processing.

Key Auditory Processing Skills

How do children find their way to DTS for an AP evaluation?

- The majority of the children we work with do not come to us because someone suspects they have an APD.
- Many are struggling with behavior, focus and attention, emotional regulation, comprehension, rational thinking, higher order/dynamic thinking, and/or struggles with peer/social pragmatic concerns.
- So our process recognizes several important factors in understanding why a child might be struggling in these areas.
- Our goal is to "consider" how the foundations of learning might be impacting other skills such as the ability to listen and comprehend.

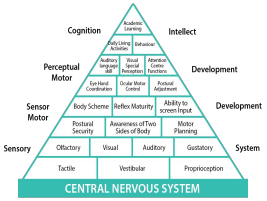
The Impact of Protection and Survival on Learning and Behavior

- How does the brain prioritize it's resources?
- What is the typical stress response
  - Stage 1 (Alarm/YELLOW LIGHT): Fight or Flight Preparation
    - Blood moves from front parts of brain to the back parts, from digestive system and sent to arms and legs
    - Eyes go into peripheral vision to "scan the horizon"
    - Auditory system focuses on low frequency sounds
    - Glucose released, heart rate increases to increase oxygen to brain, body releases cholesterol, blood clotting factor increase, pupils dilate, cortisone is released
  - Stage 2 (Response):
    - Action is taken – triggering stress hormones to dissipate
    - Without release – over production of adrenaline/corfisol will send brain into "overwhelm"
  - Stage 3 (Overwhelm/RED LIGHT):
    - Body determines that action is not happening
    - Stress hormones reach dangerous levels
    - Brain triggers detoxification
    - Blood leave large skeletal muscles to organs responsible for detox and elimination
    - Feeling of lethargy
- How does this confuse or potentially confound what we think we know about learning and/or other diagnoses?

The Role of Reflexes in development

- We are not born able to engage in "intentional" movement - reflexes spur all learning (from utero through the first several years of life)
- Reflex serve for protection and survival first. They are meant to get us upright and mobile.
- Reflexes integrate into our neurological system and support higher order thinking.
- Focus, attention, emotional regulation, comprehension, rational thinking, higher order/dynamic thinking require integrated - balanced systems.
- All of these functions fail us when we are in an "alert" state (stress, fear, anxiety)

How does Auditory Processing Influence Learning?



Pyramid of Learning (Williams and Shellenberger 1996).

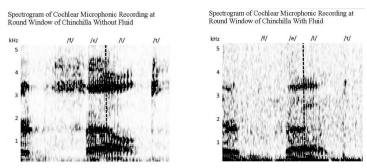
What is an Auditory Processing Disorder?

- American Academy of Speech-Language-Hearing Association (ASHA) defines Auditory Processing Disorder as a "deficit in neural processing of auditory stimulation that is not due to higher order language, cognitive, or related factors."
- In simpler terms, APD is a disruption in the brain's ability to process sound, often times resulting in a difficulties receiving, understanding, and utilizing auditory information.
- An Auditory Processing Disorder is NOT:
  - Hearing Loss
  - An intellectual disability
  - A language disorder
  - ADHD
  - A behavioral problem
  - Something a child will "grow out of"

Causes and Risk Factors for Auditory Processing Disorders (APD) in the School-Aged Population

- **Potential Causes of Auditory Processing Difficulties**
  - Disruptions in Neurological Development
  - Genetic Factors
  - Chronic Ear Infections
  - Low birth weight/prematurity
  - Traumatic Brain Injury
  - Auditory deprivation
  - Unknown etiology

Impacts of Otitis Media on Speech Perception



Impacts of Otitis Media on Auditory Processing

- OME, particularly in the first years of life, often leads to hearing loss and/or fluctuating hearing during critical developmental periods.
- Auditory deprivation and/or distortion leads to abnormal development of the central auditory nervous system (Borges, et al., 2020)
  - Maturational delays within the CANS
  - Decrease in the speed of information transmission
  - Decreased nerve fibers
- Disruption in CANS development may result in difficulty with a variety of auditory skills, including: speech-sound discrimination, speech-understanding in noise, auditory memory, and/or dichotic listening.
- An individual must be able to accurately discriminate and sequence sounds for phonological and phonemic awareness skills such as:
  - Rhyming
  - Determining initial sounds
  - Segmenting
  - Blending
  - Phoneme deletion and substitution
- Efficient auditory decoding and phonological processing skills underlie speech and language development and are closely related to reading, spelling, and written expression abilities.

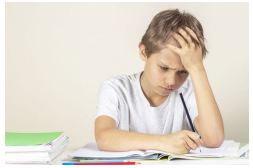
What does the Research Tell Us?

- Silva, et al. (1982) compared 5-year-old children with history of bilateral OME to those controls without history of OME.
  - Results indicated subjects with history of bilateral OME had poorer hearing, speech articulation abilities, verbal comprehension, motor development, intelligence, as well as a higher prevalence of behavior problems.
- Silva, et al. (1985) followed these same children to determine if these deficits remained at 7, 9, and 11 years of age.
  - Gaps closed in hearing, intelligence scores, and behavior problems.
  - Residual deficits noted in verbal comprehension, verbal expression, speech articulation and reading
- Bennet, et al. (2001) monitored progress at 13, 15, and 18 years of age
  - Continued deficits observed in reading ability, verbal intelligence and behavior problems reported by parents and teachers

How to Recognize APD in the Classroom

- **Listening and Comprehension Challenges**
  - Difficulty following verbal information, particularly multi-step directions
  - Frequently asks for information to repeated
  - Appears to mishear or misunderstand information
  - Struggles with listening in noisy environments
  - Slow to respond to questions or directions, requires extra time to process information
- **Academic Difficulties**
  - Poor reading and spelling skills, especially with phonics or decoding words.
  - Difficulty recalling or retaining verbal information
  - Difficulty with note-taking, particularly when listening and writing simultaneously
- **Behavioral and Social Signs**
  - Appears inattentive or distractible, especially in noisy environments.
  - May appear disengaged, frustrated, or withdrawn from classroom discussion.
  - Difficulty keeping up with group discussions
  - Hypersensitivity to sound
- **Speech and Language Concerns**
  - Struggles with speech sound articulation
  - Difficulty understanding or following complex or rapid speech
  - Poor verbal expression or trouble organizing thoughts into speech

...and now let us introduce you to Liam!



Identifying and Screening for Auditory Processing Deficits

- Parents, educators, and other support professionals are often among the first to recognize potential risk factors, behaviors, and characteristics that indicate an individual may be struggling with auditory processing deficits.
- It is within the scope of both the speech-language pathologist and audiologist to be able to recognize potential risk factors, behaviors, and characteristics that indicate an individual may be struggling with auditory processing deficits and screen for APD.
- Identification of at-risk individuals can be made using subjective observations, parent/patient report, case history, and/or formal screening tools.

Importance of Case History

- Case history is the first step in the process to gain insight into a parent's/patient's primary concerns and help guide the evaluation process.
- A thorough case history should include:
  - Chronological and developmental age
  - Prenatal, birth, and postnatal information (if patient is a child or it is relevant)
  - Medical history and current medications
  - Hearing and vision status
  - Family/Genetic history
  - Cognitive status and psychological factors (i.e. attention, memory, motivation)
  - Developmental history (i.e. speech, language, motor, social development)
  - Academic information (i.e. known learning challenges or diagnoses that impact learning)

https://www.asha.org/practice-portal/clinical-topics/central-auditory-processing-disorder/#collapse_3

Key Questions to Include to Identify Hearing & APD Concerns in Children

- Hearing and Otologic Concerns
  - Did your child pass their newborn hearing screening?
  - Do you have a family history of hearing loss?
  - Does your child have a history of ear infections?
  - Has your child undergone PE tube placement?
  - When was your child's last hearing test? What were the results?
- Auditory Behaviors & Characteristics
  - Does your child have difficulty saying speech sounds?
  - Does your child have difficulty following verbal directions/instructions?
  - Does your child have difficulty with spelling and reading?
  - Does your child have difficulty understanding speech in noisy places?
  - Is your child distracted by or sensitive to noise?
  - Is your child slow to respond to verbal directions/instruction?
  - Does your child frequently forget things told to them?

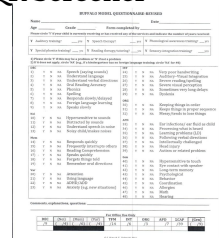
Additional Considerations Based on Case History

- Functional Vision
- Sleep Behaviors
- Pyschoeducational Assessment

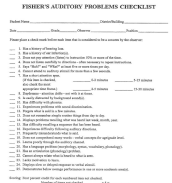
Screening for APD – Subjective Measures

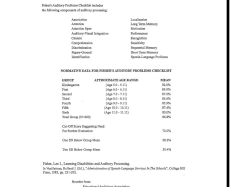
- **Buffalo Model Questionnaire**
  - Completed out by parent/guardian
  - 48 item scorable questionnaire that reviews markers in 4 subtypes of APD: Auditory Decoding, Tolerance Fading Memory, Auditory Integration, Auditory Organization
  - Complements the Buffalo Model Test Battery
- **Fisher's Auditory Problems Checklist**
  - Completed by teacher or parent by checking all behaviors listed that have been observed in the child
  - Used for Kindergarten through sixth grade
- **Children's Auditory Performance Scale**
  - Completed by teacher or parent comparing the child to class peers or age peers without auditory performance problems.
  - 36 item checklist related to 6 listening conditions: noise, quiet, ideal, multiple inputs, auditory memory sequencing, and auditory attention span.

BMQR Screener

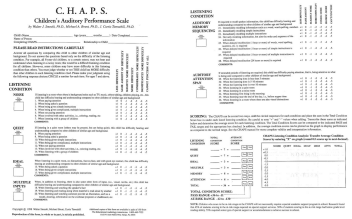


Fisher's Auditory Problems Checklist



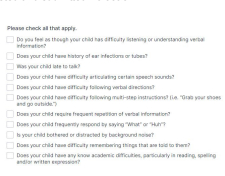


C.H.A.P.S



DTS Screening Tool

- Combination of multiple screening materials in parent friendly language that is completed and submitted via Jotform.



Screening for APD – Objective Measures

- **SCAN-3: Tests for Auditory Processing Disorders**
  - Adult and pediatric versions
  - Can be administered from ages 5;0–50;11
  - Includes Gap Detection and Auditory Figure Ground
- **Auditory Skills Assessment (ASA)**
  - Used to screen ages 3;6 – 6;11
  - Picture manual allows children to point instead of verbalizing responses
  - Includes Speech Discrimination Domain, Phonological Awareness Domain, and Non-Speech Domain
- **Feather Squadron**
  - App based games which makes it very engaging
  - Automatic scoring
  - Also has intervention features

What else do we consider as part of our process at DTS

- **Primitive Reflex Assessment**
- **Visual Processing Screening**

Break

Diagnosing Auditory Processing Disorders

- Audiologists are the sole professionals responsible for **diagnosing** APD.
- There is no gold standard for evaluating Auditory Processing Disorders.
- The APD test battery can include, but is not limited to evaluating the following skills:
  - Peripheral hearing
  - Speech understanding in noise
  - Auditory decoding/discrimination
  - Auditory integration
  - Auditory memory
  - Auditory organization/sequencing
  - Temporal processing
  - Sound localization

Diagnosing Auditory Processing Disorders

- **Appropriate age for testing:**
  - There is no consensus among professionals as to the youngest age for which children can be tested for APD.
  - Many clinics choose to wait until 7-8 years to evaluate and diagnose APD due the wide range of neuromaturation in younger children. However, there are many diagnostic tools that provide normative value down to five years of age.
- **Timing of Evaluation:**
  - An APD evaluation can take 90 minutes to 2 hours
  - Typically scheduled strategically for the morning
- **Expected Outcome:**
  - A comprehensive APD evaluation should provide information regarding areas of strength and weakness within the auditory system, with the outcome being deficit-specific recommendations for intervention.

Diagnostic Tools

- **All test batteries aim to identify strengths and weaknesses within the auditory system.**
- **There are multiple assessment tools available, including:**
  - **Buffalo Model** – Developed by Jack Katz and provides more than 40 indicators of APD. Includes Staggered Spondaic Word Test, Speech In Noise Test, and Phonemic Synthesis.
  - **SCAN** – Available version for adult and pediatric use. Includes testing for filtered words, auditory figure ground, dichotic words under directed ear listening conditions, and competing sentences.
  - **Dichotic Digits Test** – Dichotic test of binaural integration using single and double pairs of digits.
  - **Random Gap Detection Test** - uses non-verbal stimuli to test temporal resolution by determining the smallest gap between stimuli that an individual can detect.
  - **Pitch Pattern Sequence** – uses non-verbal stimuli using auditory pattern temporal ordering. Three tone bursts at either of two frequencies are presented.

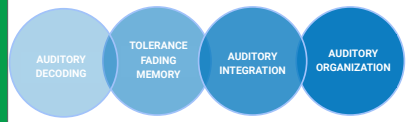
What do the tests sound like?

- Staggered Spondaic Word Test
  - The SSW test is a binaural test that presents different words to each ear.
  - Some of the words are non-competing (arriving at the two ears at separate times) and others are competing (arriving at the ears at the same time).
- Phonemic Synthesis Test:
  - This test is used to evaluate an individual's ability to discriminate individual speech sounds (auditory decoding), the degree to which these sounds are remembered effectively, and how such sounds are synthesized to into meaningful words (phonological processing).
- Speech In Noise Testing:
  - This test provides information regarding an individual's ability to process speech in the presence of background noise. Each ear is tested individually in quiet and then in noise. The percentage correct in quiet and noise are compared to determine the influence of the noise.

Scoring and Interpretation

- A comprehensive evaluation uses measures to assess both quantitative and qualitative errors and compares results to normative data for age-matched peers..
- Results look at patterns of errors across test measures to determine auditory deficits and strengths in subtype areas in order to plan for intervention.
- Objective results are combined with behavioral observations and subjective information provided by parents and teachers to gain a comprehensive understanding of auditory skills.

APD Subtypes



APD Subtypes - Decoding

AUDITORY DECODING: the ability to quickly and accurately discriminate sound

- **Symptoms:**
  - Slow to respond
  - Difficulty producing speech sounds
  - Frequently request repetition
  - Difficulty with reading, spelling, & written expression
- **Quick Tips:**
  - Repeat, not rephrase information
  - Provide additional time child to formulate response

APD Subtypes – Tolerance Fading Memory

Tolerance Fading Memory: the ability to tolerate background noise and short-term auditory memory

- **Signs & Symptoms:**
  - Difficulty with attention and focus
  - Can't remember what they heard
  - Easily distracted/bothered by background noise
  - Often cover their ears in the presence of noise
  - Reading comprehension difficulties
  - Fatigue at the end of the day
- **Quick Tips:**
  - Preferential Seating
  - Individual or small group instruction/testing
  - Get attention prior to speaking
  - Chunk longer sequences of information

APD Subtypes – Auditory Organization

AUDITORY ORGANIZATION: the ability to sequence what is heard

- **Signs & Symptoms:**
  - Messy/Unorganized in general
  - Frequently reverse or switch things around
  - Difficulty with spelling
  - Difficulty organizing thoughts and/or ideas
- **Quick Tips:**
  - Supplement auditory information with visual cues
  - Identify organizational strategies that your child enjoys

APD Subtypes – Auditory Integration

AUDITORY INTEGRATION: the brain's ability to integrate information between the left & right auditory centers, as well as with other related sensory systems (i.e. vestibular and visual)

- **Signs & Symptoms:**
  - Difficulty integrating simultaneous visual & auditory information
  - Poor social language skills
  - Delayed responses; "wait and see" approach
  - Difficulty with reading and listening comprehension
- **Quick Tips:**
  - Provide information through one modality at a time
  - Frequent checks of comprehension
  - Provide extra time for child to formulate responses
  - Communicate in clear, concise terms

Remediation of APD

- Management of APD involves a three-pronged approach that focus on improving listening, learning and communication outcomes.
    1. Environmental Modifications
    2. Compensatory Strategies
    3. Direct Intervention
- Effective remediation for students with APD typically requires collaboration between Audiologists, Speech-Language Pathologists, parents, and school administration.
    - At DTS, we also often collaborate with our Occupational Therapists.

Environmental Modifications

- Environmental Modifications focus on adjusting the listening environment that allow for maximal access to auditory information.
- The following environmental modifications may be helpful for students with suspected auditory processing difficulties:
    - Reduce background noise
    - Strategic/preferential seating
    - Use of assistive listening devices or soundfield FM systems
    - Use of sound absorbing materials (i.e. rugs, curtains)
    - Use of visual/tactile cues or daily routines
- The following communication strategies may be helpful when interacting with students with suspected auditory processing difficulties:
    - Repeating or rephrasing information that is missed
    - Use clear, concise communication
    - Reducing the rate of speech
    - Comprehension checks
    - Obtain attention prior to providing auditory information

Compensatory Strategies

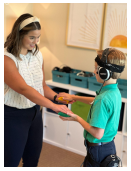
- Compensatory strategies involve teaching and promoting self-advocacy and use of strategies that improve listening outcomes.
- Many individuals with APD, especially children, are often unaware of their listening difficulties because they have no other point of reference. They may need to be taught and encouraged to use strategies that allow them to take responsibility for their listening successes and failure, such as:
    - Encouraging "active" listening techniques
    - Utilizing preferential seating
    - Asking for repetition when needed
    - Moving to a quiet environment when needed
    - Explaining their difficulties to others
    - Establishing organizational strategies and utilizing available resources to reduce demand on auditory systems (i.e. note taking, buddy system, planners, and transcription services)

Direct Intervention

- **Direct intervention** refers to targeted therapy and activities designed to directly improve the specific auditory skills that a child or individual with APD struggles with. Unlike environmental modifications or compensatory strategies, which help compensate for the challenges associated with APD, direct intervention focuses on remediating and strengthening the underlying auditory processing deficits.
- APD intervention is typically facilitated by speech-language pathologists, occupational therapists, and/or audiologists.
- A successful intervention plan starts with an understanding of the child's specific areas of auditory weakness and a multidisciplinary approach.

Collaborative Roles in APD Intervention

- **Occupational Therapists**
    - **Focus:** integration of the central auditory nervous system with other related sensory and motor systems
    - **Therapeutic Techniques:**
        - Sound therapy programs
        - Primitive reflex integration
        - Rhythm/Timing Training
        - Sensory diet implementation
- **Audiologists & Speech-Language Pathologists**
    - **Focus:** remediating the specific auditory deficits noted during the evaluation process
    - **Therapeutic Techniques:**
        - Speech Sound Discrimination
        - Speech in Noise Training
        - Dichotic Listening Exercises
        - Short-Term Auditory Memory
- **Speech-Language Pathologists:**
    - **Focus:** can additionally target higher level language/cognitive tasks that may generalize to improved auditory processing abilities
    - **Therapeutic Techniques:**
        - Phonemic Awareness
        - Auditory Sequencing
        - Auditory Comprehension
        - Following verbal directions



Goals of Intervention

- We are essentially teaching the brain to walk talk and chew gum at the same time.
- It's about brain efficiency. To improve how the brain is prioritizing energy.
- Our focus is to support the foundations by systematically activating various brain centers - increasing the demands and allowing the brain to "practice" slowly and then more quickly.
- Vestibular input, Auditory Input, Cerebellum Input, Interhemispheric demands, Prefrontal cortex demands.
- Eventual fine tuning of the auditory system with auditory training when necessary.

Sample of Intervention

- Sample including sound therapy and multisensory integration
- Sample session of phonemic training exercises
- Sample of speech in noise training
- Sample of dichotic listening exercises

Case Study: E.P.

- **Patient Demographics:**
  - 12 year old female
  - Seventh grader enrolled in typical education classroom
  - No major childhood illnesses or injuries
  - No significant history or ear infections reported
  - Positive family history of APD
- **Referral Source/Reason:**
  - Patient was referred by her ENT due to reported listening difficulties and confirmation of normal hearing.
- **Primary Concerns:**
  - Does not consistently respond to name or people talking to her unless she is giving her full attention
  - Has difficulty understanding people talking from a distance or if there is background noise
  - Slow to respond to verbal information/directions
  - Difficulty recalling verbal information
  - Can't understand teacher when she speaks with her back to the class
  - Uses closed captioning when watching TV

Case Study: E.P.

- Evaluation revealed twelve markers for APD on the Central Auditory Test Battery, with specific areas of weakness observed in:
  - Auditory decoding
  - Tolerance-fading memory
  - Auditory Integration
- Recommended intervention plan included: 45 session sound therapy program, followed by 15 sessions of auditory training focused on improving speech-sound discrimination, speech understanding in noise, and dichotic listening exercises
- E.P. completed sessions through a combination of a home program and weekly telehealth appointments.

Case Study: E.P.

	Pre-Intervention	Post-Intervention
SSW (Quantitative)	14	4
SSW (Qualitative)	10	0
PS (Quantitative)	22	25
PST (Qualitative)	22	25
Speech In Noise - Right	64%	80%
Speech in Noise - Left	36%	72%

"I definitely don't have to focus as hard to listen to people, which is nice!" - E.P. (2023)

Questions?

How does APD Differ from Other Learning Challenges?

		Definition	Key Characteristics
1	Auditory Processing Disorder (APD)	Neurological condition where the brain has difficulty processing sound, even though hearing is normal.	• Difficulty verbal directions • Trouble distinguishing sounds or mishears • Requires frequent repetition of information
2	Dyslexia	A specific learning disability that is characterized by difficulties with accurate/fluent word recognition and poor spelling and decoding abilities.	• Difficulty decoding words, slow reading • Letter reversals • Difficulty with spelling
3	ADD/ADHD	A developmental disorder affecting attention, focus, and impulse control.	• Difficulty sustaining attention • Easily distracted • Hyperactivity and impulsivity
4	Autism	A developmental disorder characterized by difficulty with social communication, interaction, and repetitive behaviors.	• Difficulty interpreting nonverbal communication • Repetitive behaviors or restricted interests • Sensory sensitivities • Possible language delays